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PROCEDURES FOR ESTIMATING DRY WEATHER POLLUTANT DEPOSITION IN SEWERAGE SYSTEMS

by

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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Reserach and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory developes new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment for public drinking water supplies and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research, a most vital communications link between the researcher and the user community.

The deleterious effects of storm sewer discharges and combined sewer overflows upon the nation's waterways have become of increasing concern in recent times. Efforts to alleviate the problem depend in part upon the development of improved flow attenuation and treatment devices.

This report presents a series of generalized predictive approaches for estimating the amount of sewage solids and other pollutants that deposit in sewerage systems during dry weather conditions. These procedures are intended to provide estimates of overall pollutant deposition for entire sewer collection systems.

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ABSTRACT

A set of generalized procedures for estimating pollutant loadings associated with dry weather sewage solids deposition in combined sewer systems has been prepared to provide planners, engineers and municipal managers with technical information so that they can make intelligent informed decisions on potential sewer flushing programs in combination with other combined sewer management controls.

The predictive equations relate the total daily mass of pollutant deposition accumulations within a collection system to physical characteristics of collection systems such as per capita waste rate, service area, total pipe length, average pipe slope, average diameter and other more complicated parameters that derive from analysis of pipe slope characteristics. Several alternative predictive models are presented reflecting anticipated differences in the availability of data and user resources. Pollutant parameters include suspended solids, volatile suspended solids, biochemical oxygen demand, chemical oxygen demand, total organic nitrogen and total phosphorous. Sewer system age and degree of maintenance was also considered. Factors are presented for estimating the increase in collection system deposition resulting from improper maintenance. A user's guide has been presented to establish the necessary data input to utilize the predictive procedures.

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LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

- CDF - cumulative distribution function
- ft - foot
- gpcd - gallons per capit per day
- kg - kilogram
- lb/day - pounds/day
- log - logarithm
- mi - mile
- WRNDB - sewerage system within the area covering portions of West Roxbury, Dedham, Newton and Brookline in metropolitan Boston.

SYMBOLS

- A - Area of collection system (acres)
- AV - Indicates a variable in the regression analysis which is available to enter the regression equation
- BOD - Biochemical Oxygen Demand (5 day)
- COD - Chemical Oxygen Demand
- $\bar{D}$ - Mean pipe diameter of a collection system, (in)
- D_i - Pipe diameter of sewer segment i, (in)
- DP - Indicates the dependent variable in the regression analysis
- e - Base of the natural logarithms;
- FI - Indicates a variable in the regression analysis to be forced in the regression equation
- FO - Indicates a variable in the regression analysis to be kept out of the regression equation.
- F_S - Indicates the cumulative probability of a value s of the pipe slopes
- G_S - Indicates complementary cumulative probability distribution
- L - Total length of the collection system (ft)
- l_i - Length of sewer segment i
- LPD - Length of pipe over which 80% of the total loads deposit in the collection system
- LPM - Estimated length of pipe over which the percentage PM of the total loads deposit in the collection system
- n - The total number of pipe segments in a collection system
- NH3 - Ammonia
- p - Particle size (mm)
- P - Total Phosphorous
- P(a) - Indicates the probability of a

PL - Percentage of pipe length corresponding to a percentage of PM of the loads depositing in the collection system

PL_D - Percentage of pipe length corresponding to 80% of the loads depositing in the collection system

$PL_D/4$ - One fourth of PL_D

PM - Any given percentage of the solids deposited in a collection system

PP - population in service area

q - Discharge per capita, including infiltration, (gpcd)

Q_{AV} - Average daily dry weather flow, (cfs)

Q_{MAX} - Peak daily dry weather flow (cfs)

r - hydraulic radius (ft)

R - Multiple regression coefficient in the regression analysis

R^2 - Portion of the total variation about the mean (predicted by the regression equation) which is explained by the re-regression

$\bar{S}$ - Mean pipe slope of the collection system

s - A particular value of pipe slope

ss - Energy slope

S_i - Slope of sewer segment i

S_G - Mean ground slope

S_{PD} - Slope corresponding to P_{LD} in the CDF of the pipe slopes

$\bar{S}_{PD}$ - Average of pipe slopes below S_{PD} in the CDF

$S_{PD}/4$ - One fourth of S_{PD}

S_{PL} - Slope corresponding to PL in the CDF of the pipe slopes

TKN - Total Kjeldhal Nitrogen

TS - Indicates the total mass of solids that deposit in the system (lb/day)

TS_{a-b} - Indicates the total mass of solids that deposit in the collection system, assuming pipe bottom sediment varying from a to b (inches)

TS - Total Suspended Solids

VSS - Volatile Suspended Solids

X - Major dimension of non-circular pipe

Y - Minor dimensions of non-circular pipe

Z_i - Percentage daily solids deposition rate in pipe segment i

ZS_i - Amount of daily dry weather sewage solids input along pipe segment i

ρ - specific weight of water

τ - Fluid shear stress

τ_C - Critical shear stress

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